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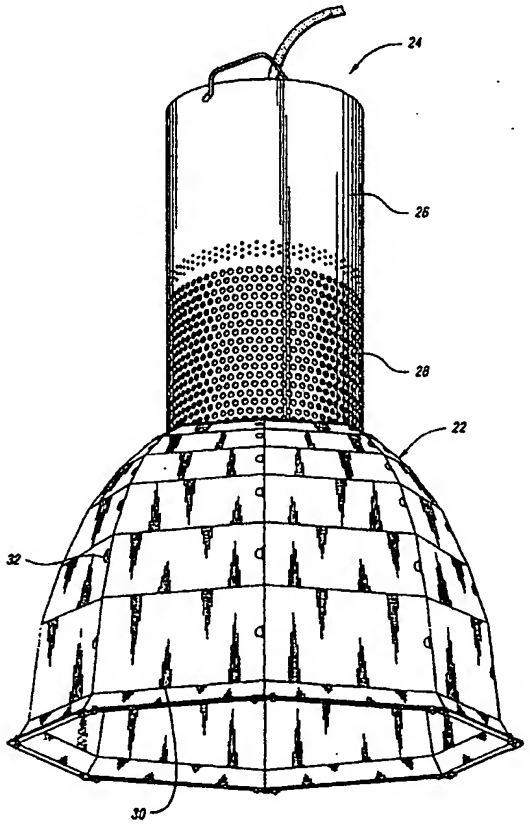
(57) Abstract

A faceted reflector assembly (22) includes a plurality of reflector segments (30) which are preferably, but not necessarily, comprised of pre-anodized and enhanced aluminum having a specular, semi-specular or a diffuse finish. The reflector segments include interlocking means such as tabs (32) and slots (34) for attachment to other reflector segments. The reflector segments (30), when interlocked, form the faceted reflector assembly (22) of the present invention.



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FACETED REFLECTOR ASSEMBLY

TECHNICAL FIELD

This invention relates to reflectors for luminaire assemblies which are particularly suited for indoor applications.

BACKGROUND ART

Suspended luminaire assemblies typically include, among other components, an optical assembly, an electrical assembly having a housing generally formed of metal for storing electrical components therein, a lamp, and a hanger member for suspending the assembly from its intended overhead location. Indoor suspended high-intensity discharge (HID) luminaires with open optics and high wattage lamps such as, for example, 400 W MH have traditionally used two kinds of optical units to direct light from the lamp onto the intended task: (1) transparent optical assemblies; and (2) opaque optical assemblies.

A typical transparent optical assembly is shown, for example, in Figure 1 and designated generally by reference numeral 10. Assembly 10 consists of either glass or plastic 12, such that the distribution of light is ensured by a reflector, a refractor, or a combination of the two which can be achieved by known techniques such as, for example, prismatic structures.

As those skilled in the art will recognize, the desirable features offered by transparent optical assemblies such as that shown in Figure 1 are high efficiency (generally greater than 90°), good light distribution, and the availability of a large uplight component. The uplight component for a glass reflector can be as high as 25% or greater of the total light emitted by the lamp. This typically includes approximately 10% coming from the top opening 14 of the reflector and approximately 15% coming through the glass 12. The fact that the glass reflector

"glows" produces a source of brightness that reduces contrast and is considered an optimal feature for many lighting tasks.

A typical opaque optical assembly is shown in Figure 2 of the drawings and is designated generally by reference numeral 16. Assembly 16 consists typically of a spun or hydro-formed metallic dome 18 having an interior which has been polished and anodized or painted with a high reflectivity white finish. The desirable feature offered by opaque optical assemblies such as the assembly 16 of Figure 2 is the cut-off produced by the dark reflector. This cut-off is specifically desirable for applications where brightness through the reflector 18 may interfere with the lighting task.

Cut-off in an opaque optical assembly is achieved at the expense of efficiency since the post-anodizing process yields a typical reflectivity of 85%. This results in luminaire efficiencies of no greater than 80%. Because the only uplight available through such a reflector 18 is from its top opening 20, the typical uplight component for metallic reflectors is generally on the order of 10%. Opaque assemblies and in particular metallic reflectors can, of course, be punched with perforations to vary the desired uplight. As those skilled in the art will recognize, metallic reflectors exist that have slots punched into them. Because of the metallic structure, however, the punching process must be performed after forming or it may tear during the spinning or hydro-forming process. Cost constraints also limit the amount of punching which can be performed subsequent to forming. Accordingly, the slots found in prior art opaque optical assemblies are generally few and large due to the constraints indicated above of the manufacturing processes. Such slots provide few large patches of uplight that are generally too bright and fail to produce uniform light distribution on the ceiling.

Consequently, a need exists for a reflector which can produce efficiencies typical of glass reflectors yet having the cut-off typical of metallic reflectors. Such a reflector should also accommodate perforations as a means to vary the uplight component as well as the overall appearance of the optical assembly.

DISCLOSURE OF THE INVENTION

It is a principal object of the present invention to provide an improved reflector having the efficiencies typical of glass reflectors with the cut-off typical of metallic reflectors.

It is a further object of the present invention to provide an improved reflector having a means to provide a varying amount of uplight without sacrificing cut-off.

It is still another object of the present invention to provide an improved reflector having a means for varying uplight typical of that provided by glass and plastic reflectors.

It is yet another object of the present invention to provide an improved reflector which can produce a radial distribution similar to that of typical HID reflectors.

Yet still further, it is an object of the present invention to provide an improved reflector which offers the ability to change its symmetry so as to efficiently produce biaxial distributions.

Still further, it is an object of the present invention to provide an improved reflector which can be manufactured with a low tooling investment for a large degree of design flexibility.

In carrying out these and other objects, features and advantages of the present invention, there is provided a faceted reflector for use in a suspended luminaire. The faceted reflector includes a plurality of reflector segments each having interlocking means for attachment to another segment. The plurality of segments when interlocked form the faceted reflector.

In a preferred embodiment, each of the reflector segments is comprised of pre-anodized and enhanced aluminum having a specular, semi-specular, or a diffuse finish. The segments have a substantially curved cross section in a vertical plane. When interlocked to form the faceted reflector, a dome-shaped optical unit is formed having a regular polygonal cross section in a horizontal plane. Still further, in the preferred embodiment, the interlocking means includes a plurality of tabs and slots for interlocking with respective slots and tabs of other segments.

In yet another embodiment, the faceted reflector includes a plurality of perforations in one or more of the reflector segments according to predetermined patterns so as to allow light to pass therethrough.

The above objects and other objects, features and advantages of the present invention are readily apparent from the following detailed description of the best mode for carrying out the invention when taken in connection with the accompanying drawings.

BRIEF DESCRIPTION OF DRAWINGS

FIGURE 1 is a perspective view of a prior art transparent optical assembly;

FIGURE 2 is a perspective view of a prior art opaque optical assembly;

FIGURE 3 is a perspective view of the faceted reflector assembly of the present invention shown as part of a luminaire assembly;

FIGURE 4 is a perspective view of the faceted reflector assembly of the present invention;

FIGURE 5 is a bottom view of the reflector assembly of Figure 4;

FIGURE 6 is a perspective view of an alternative embodiment of the reflector assembly of the present invention shown having a plurality of perforations in its upper portion;

FIGURE 7 is a bottom view of the reflector assembly of Figure 6;

FIGURE 8 is a plan view of a bent reflector segment;

FIGURE 9 is a cross-sectional view of Figure 8 through line 9-9;

FIGURE 10 is a plan view of an alternative embodiment of a reflector segment;

FIGURE 11 is a cross-sectional view of Figure 10 through line 11-11;

FIGURE 12 is a plan view of an additional alternative embodiment of a reflector segment;

FIGURE 13 is a cross-sectional view of Figure 12 through line 13-13;

FIGURE 14 is a plan view of an additional alternative embodiment of a reflector segment;

FIGURE 15 is a cross-sectional view of Figure 14 through line 15-15;

FIGURE 16 is a plan view of an additional alternative embodiment of a reflector segment;

FIGURE 17 is a cross-sectional view of Figure 16 through line 17-17;

FIGURE 18 is a perspective view of an alternative embodiment of reflector assembly 22;

FIGURE 19 is a perspective view of an alternative embodiment of reflector assembly 22; and

FIGURE 20 is a bottom view of the reflector assembly shown in Figure 19.

BEST MODE FOR CARRYING OUT THE INVENTION

Figures 3-7 show the faceted reflector of the present invention in an assembled condition. As seen, reflector 22 is adapted to be fixed to an electrical assembly 24 having a housing 26 which is generally formed of metal for storing electrical components therein such as a ballast, a capacitor, a lamp, a starter, a relay, etc., all of which are known to those of ordinary skill in the art and thus not shown herein. Housing 26 is preferably made of sheet metal, but may, of course, be comprised of any suitable material having sufficient strength and thermal stability to dissipate heat generated by the internal electrical components. Housing 26 may also include one or more illumination perforations 28 for providing a patterned outlet of illumination from the lamp. Illuminating perforations 28 may form any pattern, design, or character string, the shape, spacing and location of which are limited only by the designer's imagination, as well as the size and stability of housing 26, and of course the intended task. Each individual perforation 28 may have a variety of shapes including, but not limited to, a square, a circle, or a triangle of any given orientation, a star, a cross or plus sign, a rectangle in any staggered or other type of orientation. Of course, it is further contemplated that each of these individual shapes may be used in any combination with any one or more of the individual shapes. As indicated above, illumination perforations 28 may also include a design or a character string.

Reflector 22 which comprises the present invention is made up of a plurality of reflector segments or wedges 30 which are preferably, but not necessarily, made of high reflectivity pre-anodized and enhanced aluminum having a finish suitable for the intended task such as, for example, specular, semi-specular, or diffuse. In operation, reflector segments 30 are formed on a press brake or other

suitable tooling known to those of skill in the art. Reflector segments 30, feature either bends as shown more clearly in Figures 8-9 or a smooth curved cross section in a vertical (radial) plane as shown more clearly in Figures 10-11. Reflector segments 30 are designed to interlock with one another using suitable interlocking means such as tabs 32 and slots 34 so as to create a faceted dome having a regular polygonal cross-section in a horizontal plane. This method of construction has been found necessary to allow the use of the pre-finished high reflectivity material. Conventional manufacturing processes for HID indoor metal reflectors such as spinning and hydro-forming have been found to draw the metal to such an extent that any pre-applied high reflectivity finish such as that used in the present invention is destroyed through the stretching of the metal.

Referring to Figures 6-7, 12-13, and 14-17, each or some of reflector segments 30 can similarly be perforated with a plurality of illumination perforations 36 for providing a predetermined outlet of illumination through the respective segment. Illumination perforations 36, like those in housing 26 may form any pattern, design, or character string which again is limited only by the imagination of the designer, the size and stability of the segment, and again, the intended task. Each individual perforation 36 may also have a variety of shapes including, but not limited to, a square, a circle, a triangle having any given orientation, a star, a cross, or plus sign, or a rectangular in any staggered or other type of orientation. Again, it is fully contemplated that each of these individual shapes may be used in any combination with any one or more of the other individual shapes. As mentioned, illumination perforations 36 may also include a design or a character string.

Illumination perforations 36 may also be placed at predetermined locations throughout the respective reflector segments 30 depending on the desired illumination effect. For example, when illumination perforations are located near the top 38 of reflector 22, the light passing through the reflector may be delivered as uplight in the 90-80% from vertical zone. Perforations 36 can be inexpensively applied before the reflector wedges are formed and assembled using CNC sheet metal punching equipment and individual or cluster tools.

Referring now to Figures 18-20 of the drawings, it is further understood that the horizontal cross section of the faceted reflector 22 formed of segments 30 can also be varied from a regular polygon to an irregular polygon thus providing a variety of biaxial and asymmetric distributions. The number of reflector segments 30 may also be varied to produce a horizontal cross section of a polygon with an increasing number of sides. For each specific distribution desired, an optimum number of reflector segments is required to produce uniformity in the resulting lighting layout. For example, a reflector design that uses four segments will produce a predominantly square distribution in the horizontal plane yet distorted by "spikes" caused by the 90° corners of the reflector.

The present invention optimizes the design from both a performance and a cost standpoint by using the minimum number of segments necessary to satisfy the application uniformity criteria. For example, it is presently believed that 8 segments will optimize many typical applications. In keeping with the invention, reflector segments 30 may also be made from high reflectivity (generally on the order of greater than 90%) metal painted white. In this manner, the reflector will provide all the uplight features discussed above but will be limited to an efficiency of approximately 80% similar to that of traditional metal reflectors resulting from the inability of white paint to precisely aim light out of the luminaire. The attractive feature of such a reflector, however, is its potentially low cost since thin gauge steel post-painted and inhouse operation can be used for construction as opposed to traditional aluminum required by spinning and hydro-forming processes.

The invention as described and claimed herein, thus results in a faceted reflector which produces cut-off without sacrificing efficiency. More specifically, with the use of highly reflective specular material, efficiencies (greater than 90%) are possible with reflector sizes comparable to traditional ones. Accordingly, the faceted reflector 22 may produce efficiencies typical of glass reflectors yet with the cut-off typical of metallic reflectors. Still further, the invention produces a means of providing a varying amount of uplight without sacrificing cut-off. By selectively perforating the upper portions 38 of reflector segments 30, and by varying the amount of punching, greater or less uplight may be

provided. Furthermore, the light exiting each of the respective reflector segments 30 through the perforations 36 can be practically contained to the 90-180° from vertical zone thus replicating the cut-off distribution offered by metallic reflectors.

Still further, the faceted reflector 22 described and claimed herein produces a means of varying uplight from zero (with a closed top reflector) to approximately 25% or more thus matching the amount of uplight offered by glass and/or plastic reflectors. As discussed above, illumination perforation 36 may have any shape, or position as well as density. A dense pattern of closely spaced perforations 36 may be applied to the top portion 38 of the reflector segments 30 thus producing a strong uplight component of 25% or more. Perforations 36 may also be applied to some but not all of the reflector segments resulting in luminaire brightness and uplight in one viewing direction and low luminaire brightness without uplight in a viewing different direction. Because of the modular (segmented) construction of the faceted reflector 22 herein, perforated and solid segments can also be alternated using a diversity of luminaire appearances and luminosity. For example, a reflector that has perforations on half of its reflector segments with remaining segments being solid may be constructed. The perforated side of the reflector may be faced to a retail store window or other desired attention area thus producing brightness and an "open look" while the solid side can be faced to the back of the store or non-viewing area increasing the light onto the merchandise.

Finally, the invention described and claimed herein produces a unique soft look of the reflector which is currently not available in the market. As is readily seen, the look of the perforated faceted reflector 22 may be softer than that of a transparent glass or plastic. Through strategic placement of the perforations 36, a strong uplight component may be delivered without excessive brightness. The entire reflector 22 can, of course, also be perforated with very small openings providing a very soft glowing appearance. Again, none of these unique appearances are presently available in the marketplace.

The radial symmetric distribution described above may be achieved when the horizontal cross section of the segmented reflector is a regular polygon.

However, as indicated, by stretching the horizontal cross section in one or more directions, and by varying the vertical cross section of the reflector segments 30, it is anticipated that asymmetric and biaxial light distributions such as long and narrow can be created as shown, for example, in Figures 18-20. These light distributions can be created while at the same time maintaining all the other key benefits offered by the present invention such as efficiency, cut-off and uplight. These speciality distributions produce superior lighting in certain application layouts over radial symmetric reflectors. An example is the long and narrow distribution applied to the lighting of warehouse racks in narrow aisles.

While embodiments of the invention have been illustrated and described, it is not intended that these embodiments illustrate and describe all possible forms of the invention. Rather, the words used in the specification are words of description rather than limitation, and it is understood that various changes may be made without departing from the spirit and scope of the invention.

WHAT IS CLAIMED IS:

1. A faceted reflector for use in a suspended luminaire comprising:

a plurality of reflector segments, each segment having interlocking means for attachment to another segment,

whereby the plurality of reflector segments when interlocked form the faceted reflector.

2. A faceted reflector as in claim 1, wherein each of the reflector segments has a substantially curved cross section in a vertical plane.

3. A faceted reflector as in claim 1, wherein each of the reflector segments is comprised of pre-anodized and enhanced aluminum.

4. A faceted reflector as in claim 1, wherein each of the reflector segments has a specular finish.

5. A faceted reflector as in claim 1, wherein each of the reflector segments has a semi-specular finish.

6. A faceted reflector as in claim 1, wherein each of the reflector segments has a diffuse finish.

7. A faceted reflector as in claim 1, wherein at least one of the reflector segments has a specular finish.

8. A faceted reflector as in claim 1, wherein at least one of the reflector segments has a semi-specular finish.

9. A faceted reflector as in claim 1, wherein at least one of the reflector segments has a diffuse finish.

10. A faceted reflector as in claim 1, wherein the plurality of reflector segments when interlocked have a regular polygonal cross section in a horizontal plane.

11. A faceted reflector as in claim 1, wherein the interlocking means comprises tabs and slots.

12. A faceted reflector as in claim 1, wherein at least one of the reflector segments includes a plurality of perforations.

13. A faceted reflector for use in a suspended luminaire comprising:

a plurality of pre-anodized and enhanced aluminum reflector segments, each segment having a substantially curved cross section in a vertical plane and including a plurality of tabs and slots for interlocking with respective slots and tabs of other segments,

whereby the plurality of reflector segments when interlocked form the faceted reflector having a regular polygon cross section in a horizontal plane and typically result in a radial lighting distribution.

14. A faceted reflector as in claim 13, wherein at least one of the reflector segments includes a plurality of perforations.

15. A faceted reflector for use in a suspended luminaire comprising:

a plurality of pre-anodized and enhanced aluminum reflector segments, each segment having a substantially curved cross section in a vertical plane and including a plurality of tabs and slots for interlocking with respective slots and tabs of other segments,

whereby the plurality of reflector segments when interlocked form the faceted reflector having an irregular polygonal cross section with two perpendicular axes of symmetry and typically result in a biaxial lighting distribution.

16. A faceted reflector for use in a suspended luminaire comprising:

a plurality of pre-anodized and enhanced aluminum reflector segments, each segment having a substantially curved cross section in a vertical plane and including a plurality of tabs and slots for interlocking with respective slots and tabs of other segments,

whereby the plurality of reflector segments when interlocked form the faceted reflector having an irregular polygonal cross section in a horizontal plane with one axis of symmetry and typically result in an asymmetric lighting distribution.

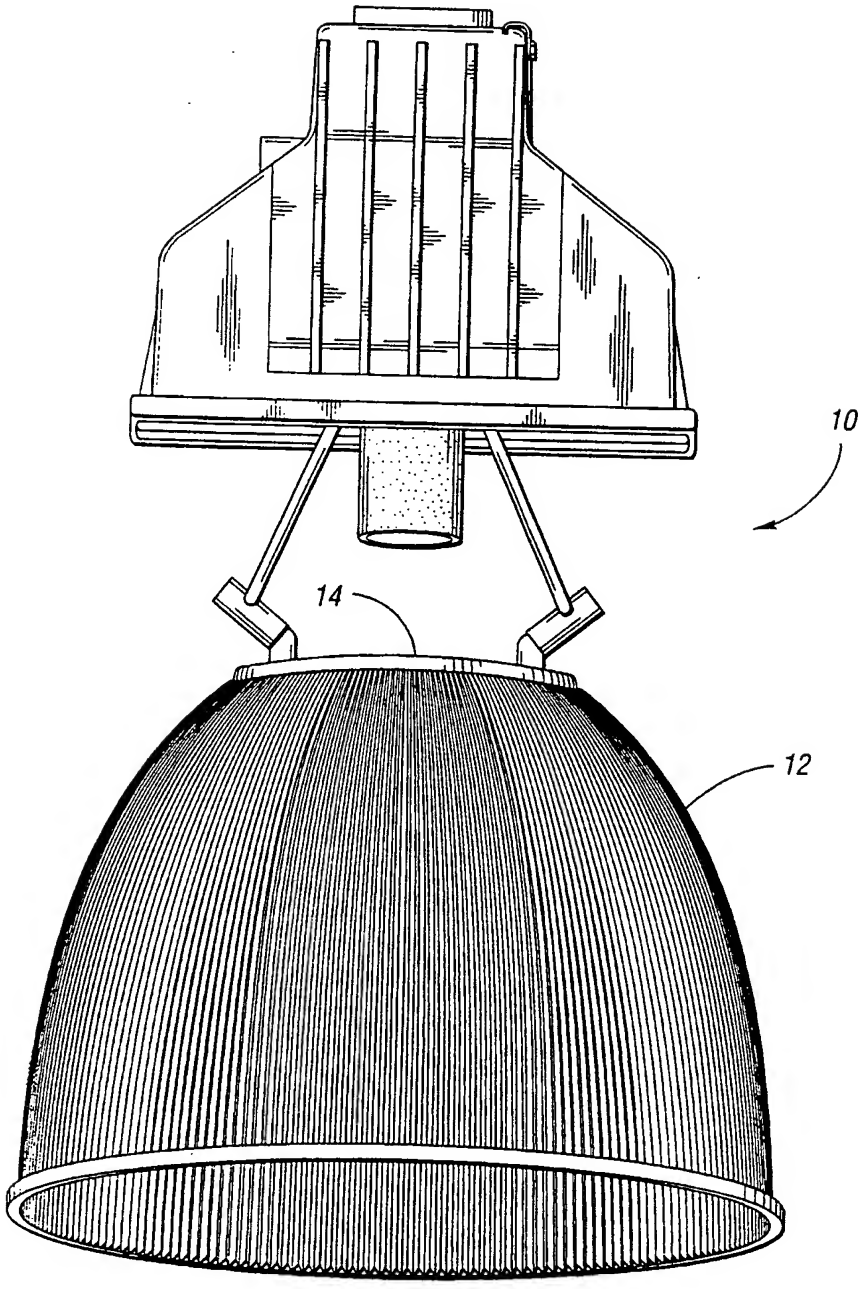


Fig. 1 (PRIOR ART)

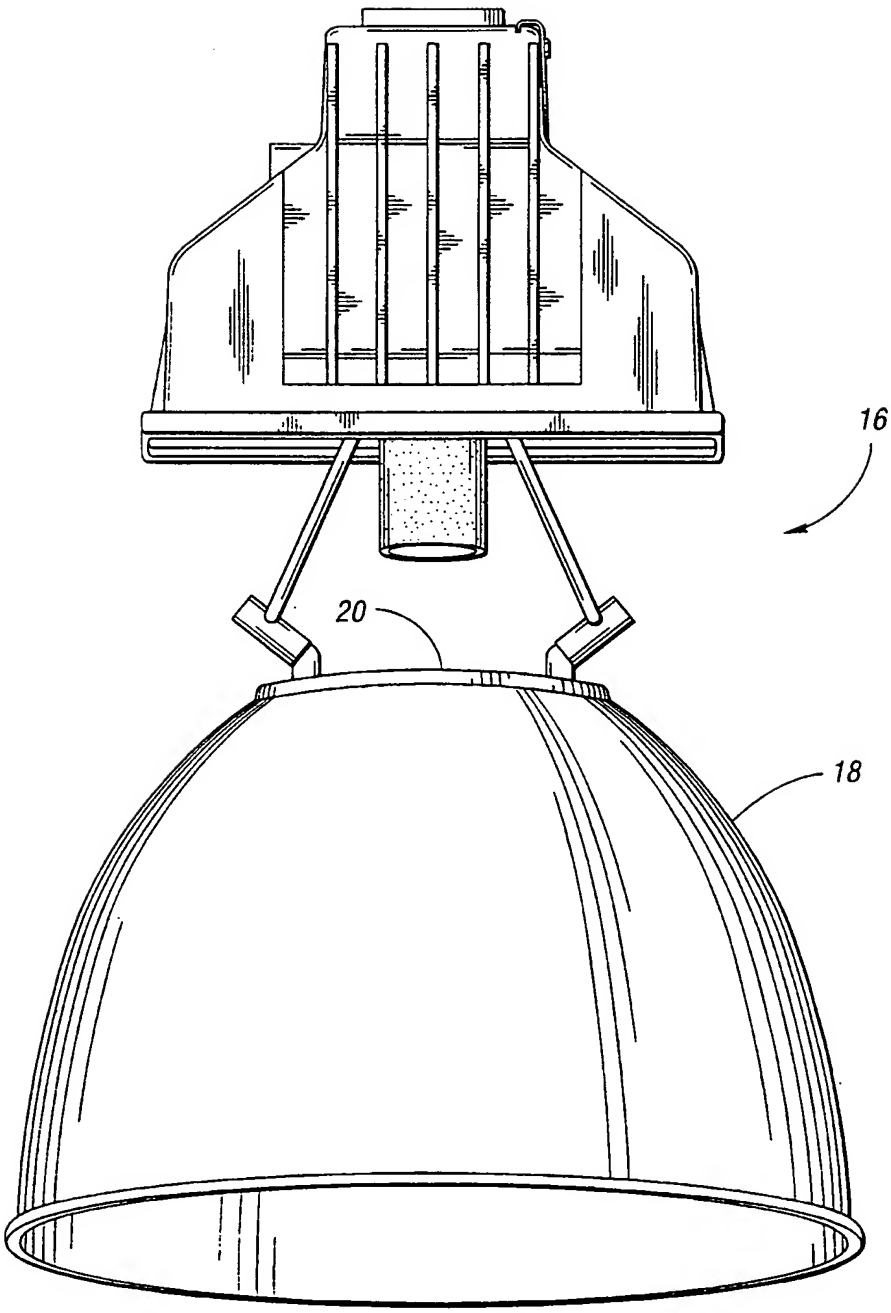


Fig. 2
(PRIOR ART)

Fig. 3

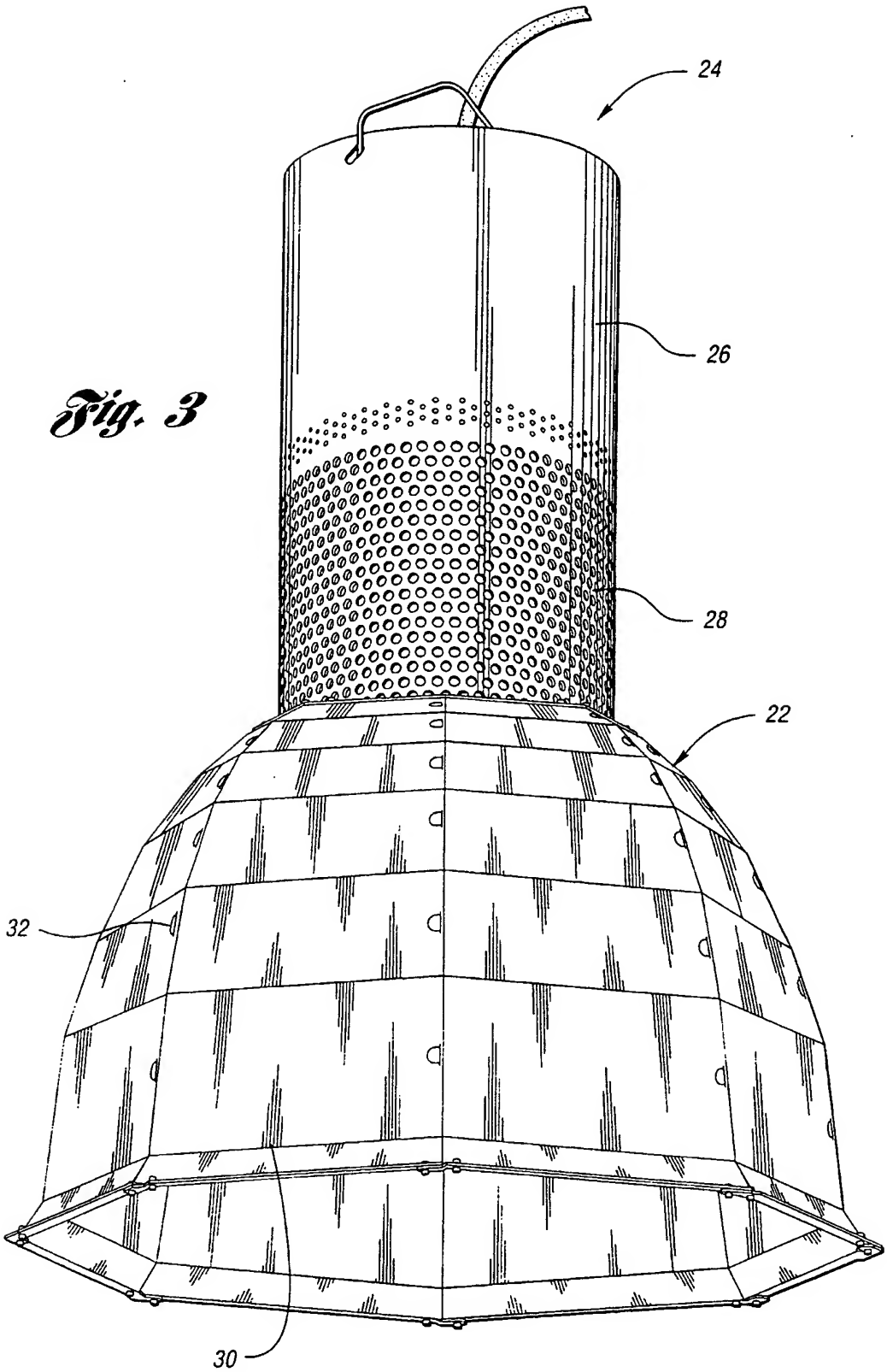


Fig. 4

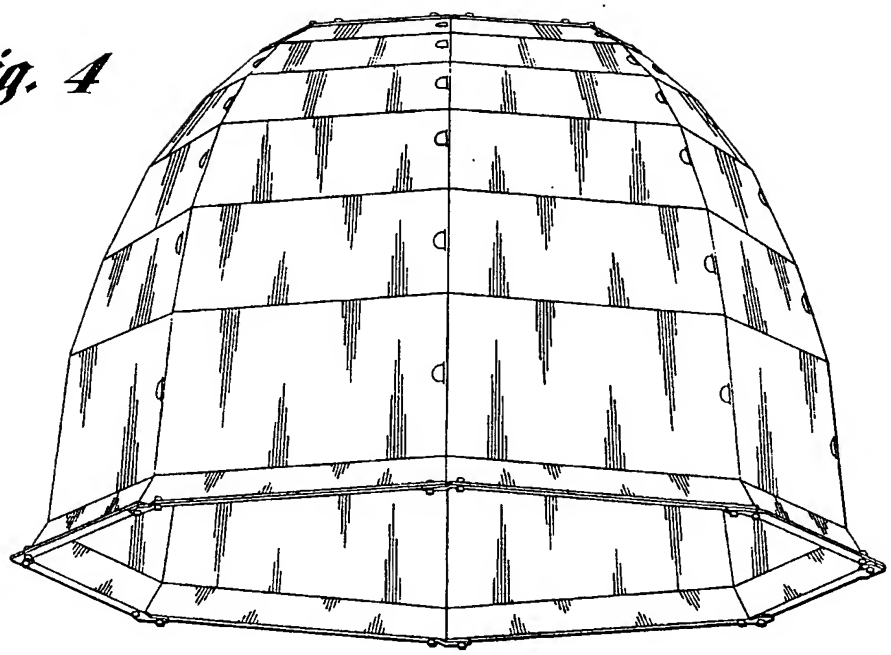


Fig. 5

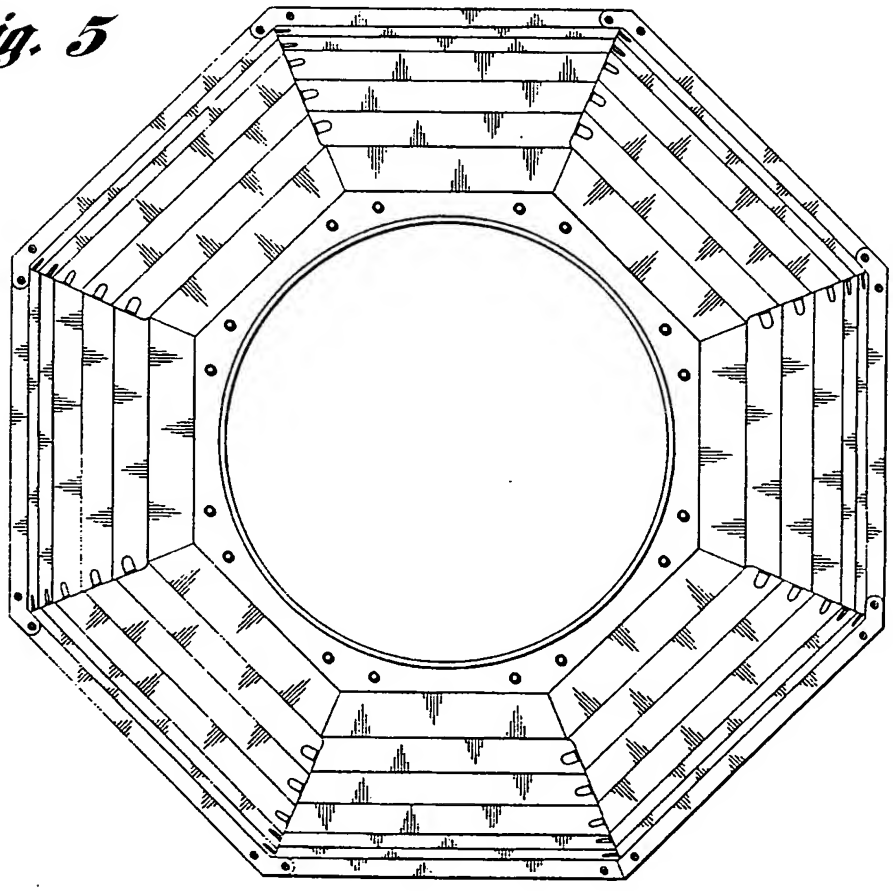


Fig. 6

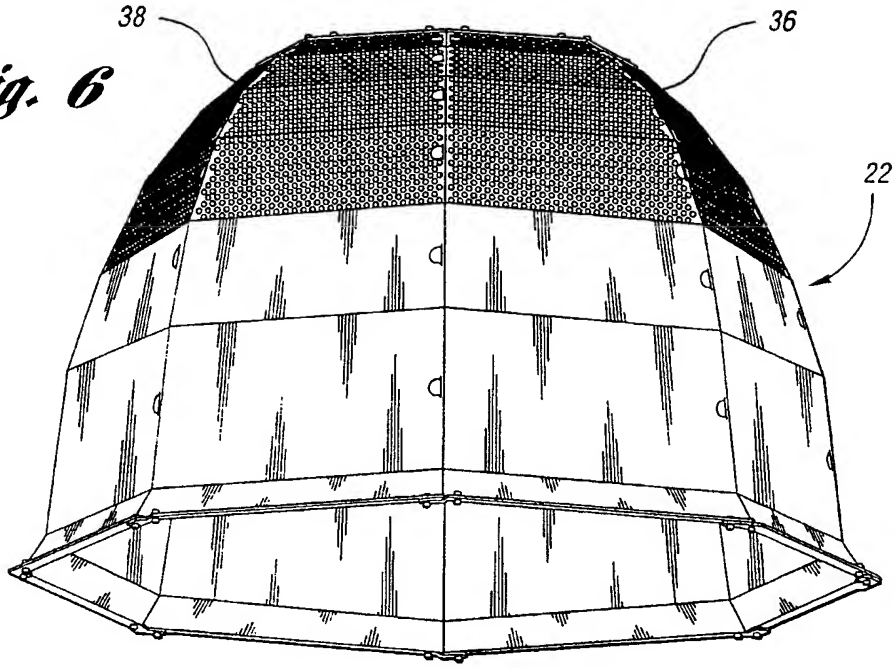
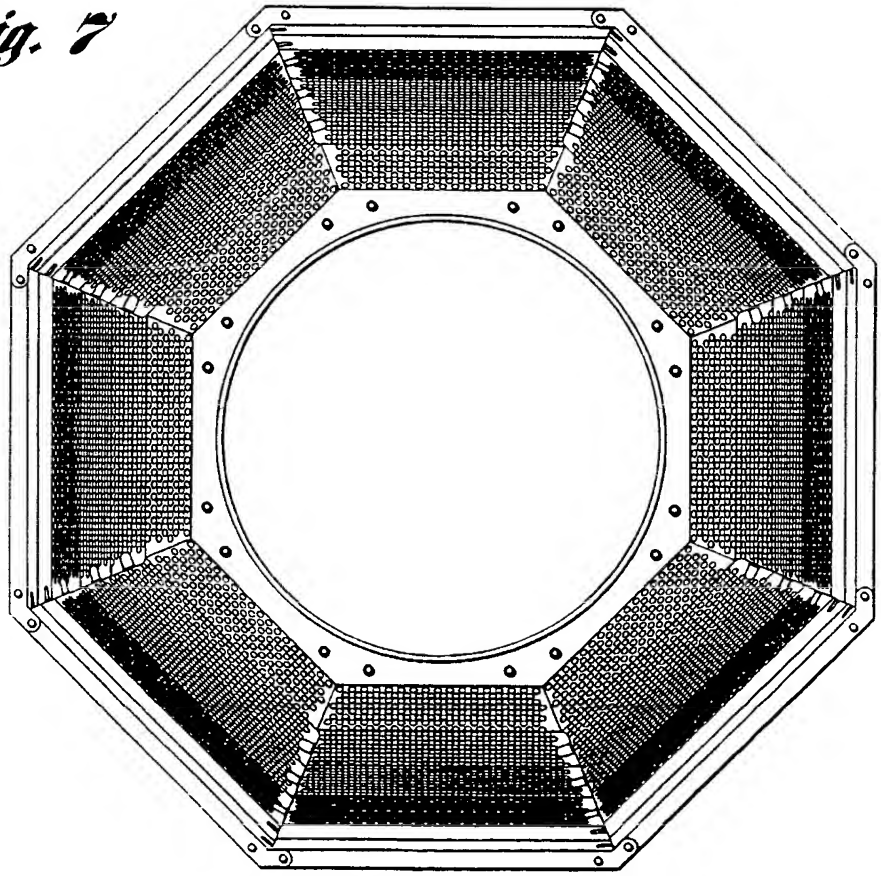


Fig. 7



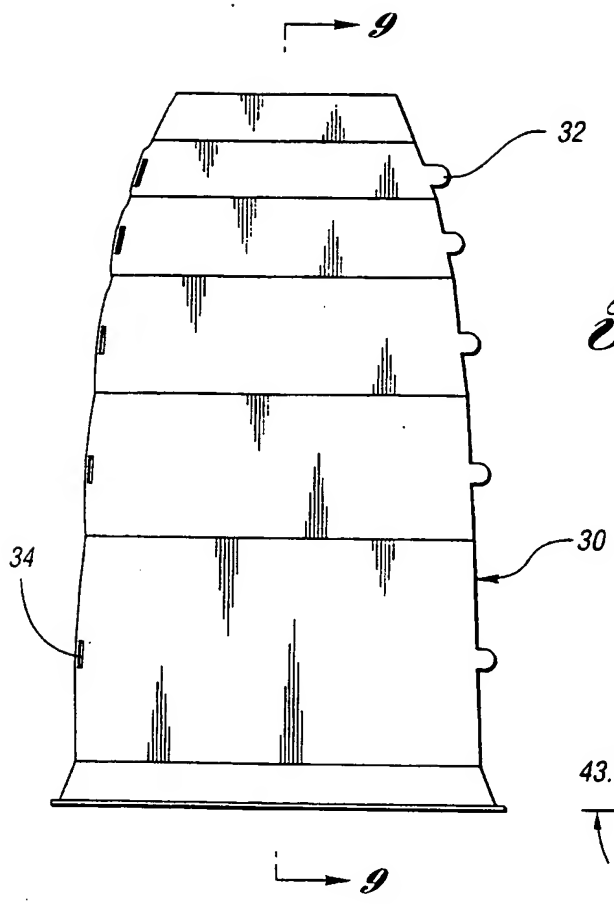


Fig. 8

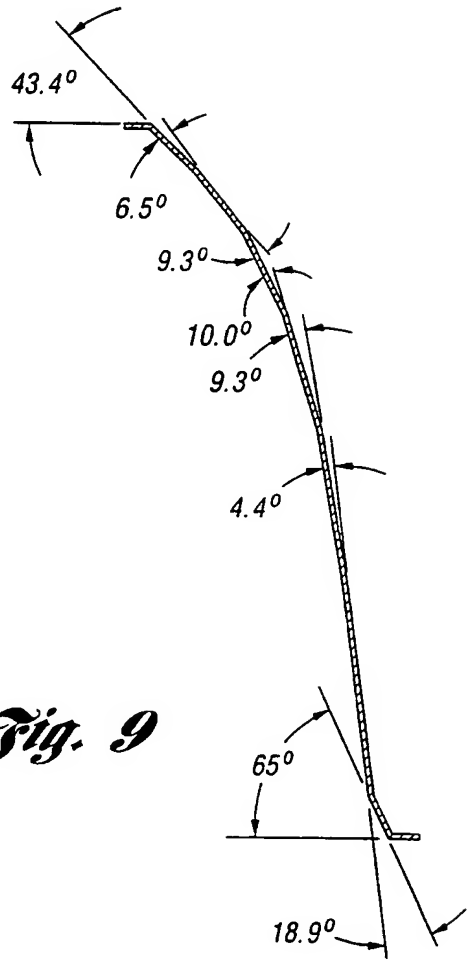


Fig. 9

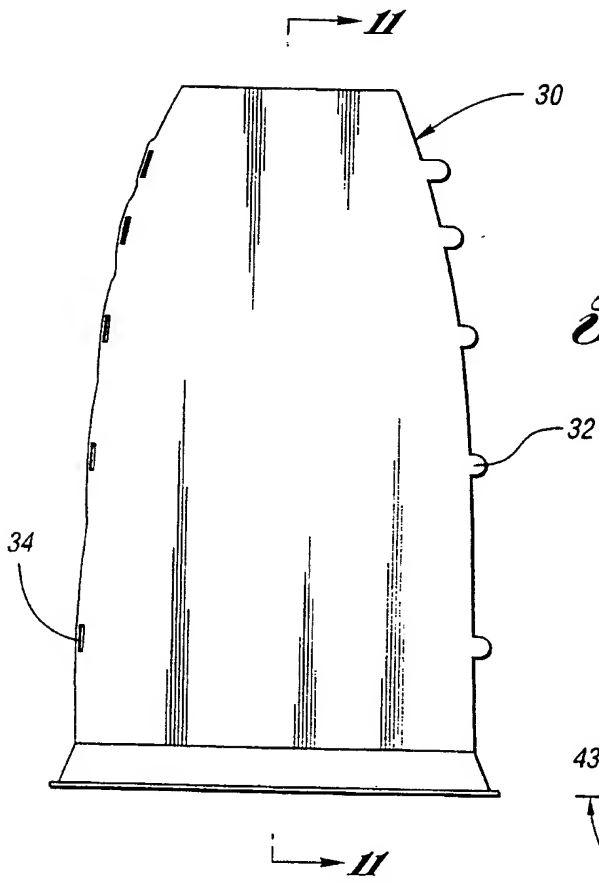


Fig. 10

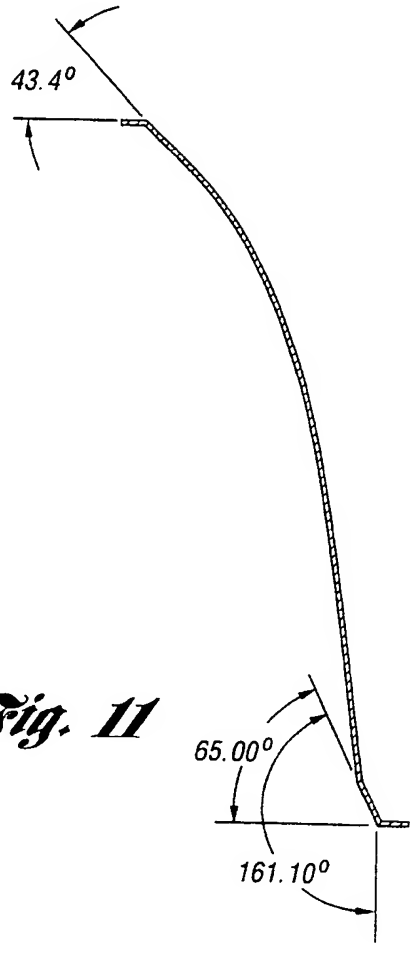


Fig. 11

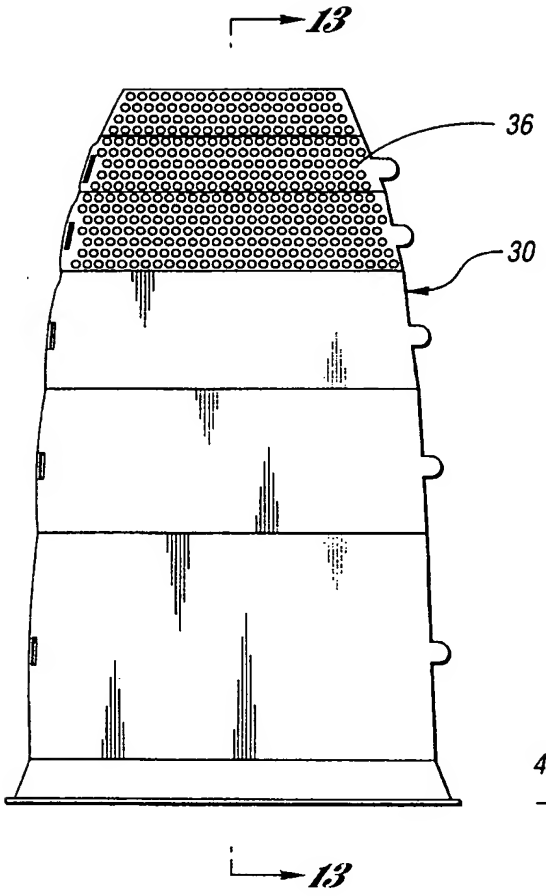


Fig. 12

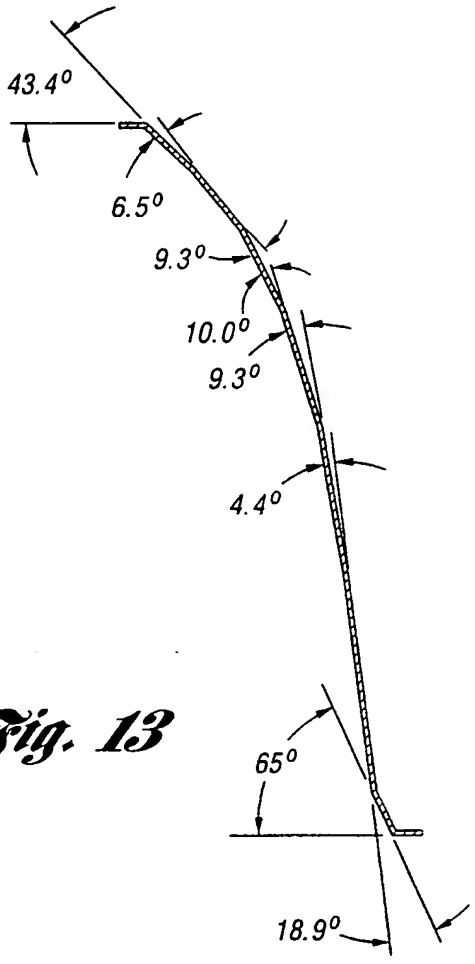


Fig. 13

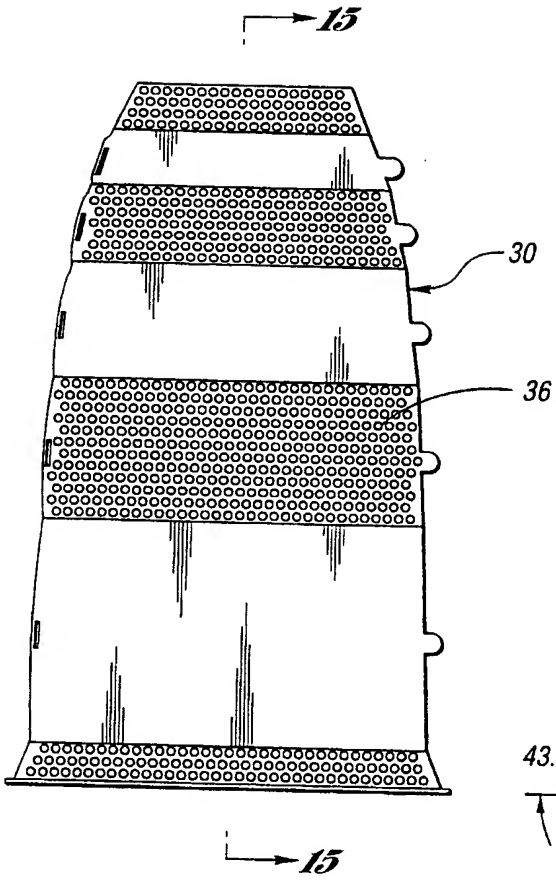


Fig. 14

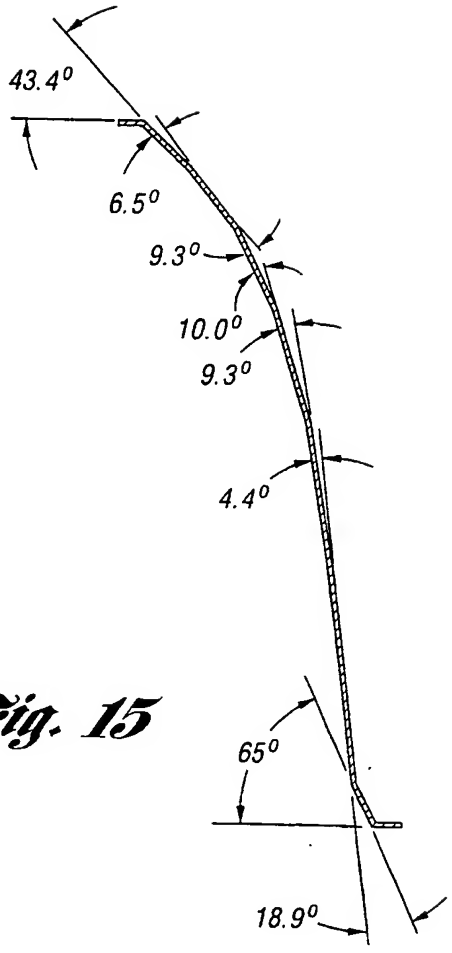


Fig. 15

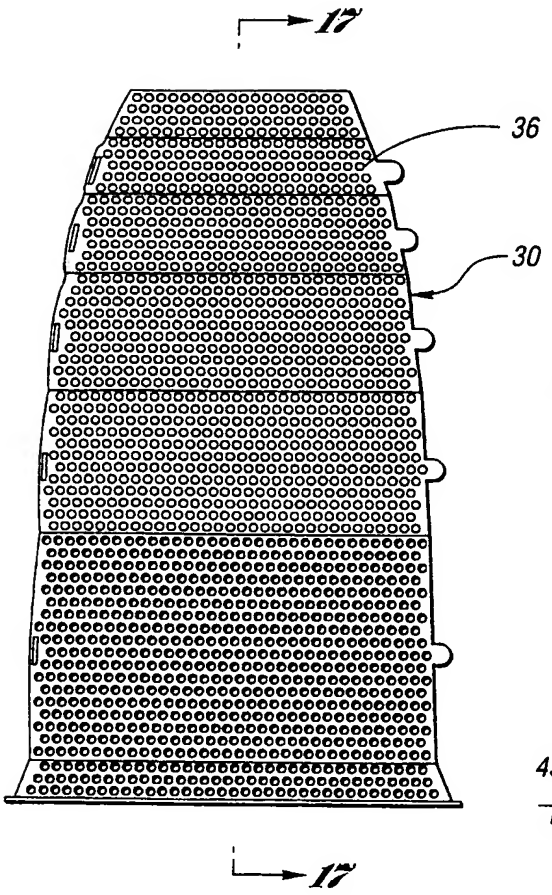


Fig. 16

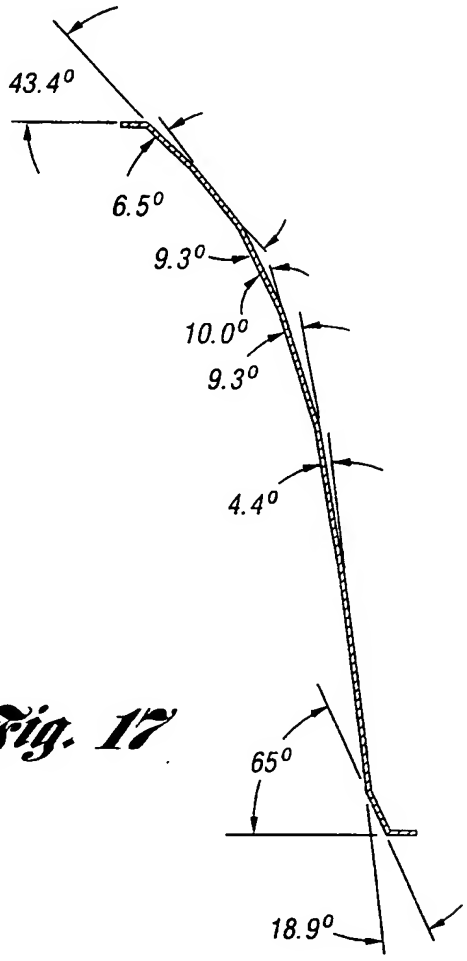


Fig. 17

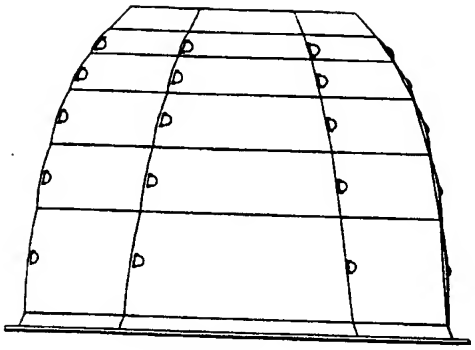
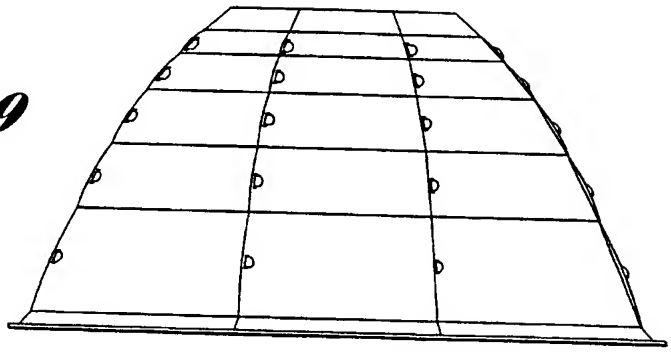


Fig. 18

Fig. 19



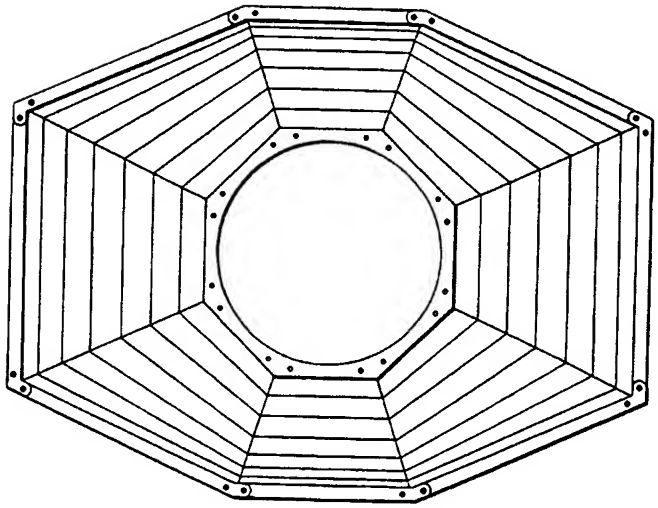


Fig. 20

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US00/02664

A. CLASSIFICATION OF SUBJECT MATTER
IPC(7) :G02B 5/08
US CL :359/850
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
U.S. : 359/850, 851

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
None

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
Please See Extra Sheet.

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X --- Y	US 5,287,259 A (LAUTZENHEISER) 15 February 1994 (15-02-1994), whole document.	1-3, 10, 12 ------ 4-9, 11, 13-16
Y	US 4,261,030 A (HERNANDEZ) 07 April 1981 (07-04-1981), col. 5 lines 35-37.	11, 13-16
Y	US 4,188,657 A (REIBLING) 12 February 1980 (12-04-1980), col. 5 lines 9-15.	4-9

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

*	Special categories of cited documents:	"T"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A"	document defining the general state of the art which is not considered to be of particular relevance	"X"	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"E"	earlier document published on or after the international filing date	"Y"	document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"L"	document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&"	document member of the same patent family
"O"	document referring to an oral disclosure, use, exhibition or other means		
"P"	document published prior to the international filing date but later than the priority date claimed		

Date of the actual completion of the international search 15 MARCH 2000	Date of mailing of the international search report 04 APR 2000
Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. (703) 305-3230	Authorized officer JENNIFER WINSTEDT Telephone No. (703) 305-057[illegible]

Form PCT/ISA/210 (second sheet) (July 1998)*

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US00/02664

B. FIELDS SEARCHED

Electronic data bases consulted (Name of data base and where practicable terms used):

USPTO APS BRS(EAST)

search terms: slot, tab, slots, tabs, reflector segments, mirror segments, semi specular finish, semispecular finish, pre anodized, preanodized, aluminum, mirror, reflector, faceted